ATLANTIC BRANT MANAGEMENT PLAN

July 2002

Technical Section
Snow Goose, Brant, and Swan Committee

ATLANTIC BRANT MANAGEMENT PLAN

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STATEMENT OF PURPOSE

The purpose of this plan is to provide management goals, objectives, and strategies for Atlantic brant conservation. The Action Plan outlines steps necessary for appropriate brant management. The Hunt Plan documents goals and objectives for brant harvest and contains strategies to attain them. The Research Plan identifies information needed to improve the approaches outlined in the Action and Hunt Plans. The Plan also includes the data sets used to manage the Atlantic brant population and descriptions of past and present surveys used to monitor the population and its habitats.

MANAGEMENT PLAN GOAL

The management goal is to perpetuate Atlantic brant and their habitats while providing optimum opportunity for people to use and enjoy brant on a sustainable basis that is consistent with international treaties.

SECTION 1.

ATLANTIC BRANT ACTION PLAN

Objectives, Strategies, and Tasks

OBJECTIVE I: Maintain the long-term Atlantic brant Mid-Winter Waterfowl Survey index at or above 124,000, the North American Waterfowl Management Plan population goal.

Rationale: The recreational, aesthetic, scientific, and ecological values associated with Atlantic brant are best realized from a healthy, sustainable population. Maintenance of populations of migratory birds is mandated by international treaties (U.S. Fish and Wildlife Service 1988).

Strategy I.A: Develop and implement hunting regulations that are consistent with the NAWMP goal of 124,000 brant in the Mid-winter Waterfowl Survey index.

Hunting is a major source of mortality for Atlantic brant and the primary mortality source that is subject to control by managers. According to the Migratory Bird Treaty, hunting is a secondary consideration to maintaining populations of migratory birds (U.S. Fish and Wildlife Service 1988). The

current hunt plan seeks to address this issue, however, the effect of regulation packages on brant harvest and thus survival and population dynamics remains unclear.

Strategy I.B: Maintain and improve population surveys and associated databases necessary to assess the population status of Atlantic brant.

Rationale: Annual assessment of the Atlantic brant population is needed to guide management decisions. Atlantic brant occasionally experience production failures related to weather on the high-Arctic breeding grounds. High winter mortality has been documented in years of unusually severe weather. Aboriginal people as well as sport hunters in Canada and the United States harvest Atlantic brant. These harvests should be quantified. Several important surveys have been discontinued, several face uncertain funding, and several surveys require further evaluation.

Task I.B.1: Continue to conduct an annual mid-winter survey for Atlantic brant, and explore means of improving the accuracy and precision of population estimates.

The Mid-winter Waterfowl Survey (MWS) is the only assessment of population size for Atlantic brant. The MWS is believed to provide a reasonably good long-term index (Kirby and Obrecht 1982). There are currently discussions about discontinuing the MWS or changing its protocols. The importance of this survey to Atlantic brant management should be carefully considered by those deciding its fate to assure that the long-term database is not compromised.

Responsibility: Atlantic Flyway states, U.S. Fish and Wildlife Service

Task I.B.2: Continue to conduct the Fall Productivity Survey during November within all states that contain concentrations of Atlantic brant.

This is the only on-the-ground assessment of brant production available.

Responsibility: New York, New Jersey, Delaware, Maryland, Virginia, U.S. Fish and Wildlife Service, National Wildlife Refuges.

Task I.B.3: Implement the Harvest Information Program in a way that will insure the best possible estimates of U.S. brant harvest.

The harvest estimates derived from current U.S. Federal harvest survey have poor precision (Geissler 1990) and accuracy (Rogers 1979) for brant. Proper implementation of the HIP should improve harvest estimates and our ability to determine the effects of regulations on harvest.

Responsibility: All states (especially those with significant brant harvest), U.S. Fish and Wildlife Service.

Task I. B.4: Obtain or improve estimates of sport and subsistence harvest of Atlantic brant in Canada.

Harvest by sport hunters in Canada is currently estimated through the National Harvest Survey and since 1975 has averaged about 800 birds per year. Harvest by subsistence hunters in Canada takes place mainly in James Bay at about 7,600 brant per year (A. Reed, Canadian Wildlife Service, see harvest management review) in Quebec and a few hundred in James Bay, Ontario. A few Atlantic brant are also killed in the Baffin and Keewatin Regions of Nunavut. This constitutes about 30% of the average estimate of harvest in the U.S. from 1958 to 1999, excluding closed seasons. Consequently, subsistence harvest may play an important role in brant population dynamics.

Responsibility: Canadian Wildlife Service

Task I.B.5: Develop models of brant production that provide useful estimates early enough to be used in the annual regulations cycle.

The Spring Satellite Survey that has historically been used to predict brant production has performed poorly during recent years. In 1999, for example, production was predicted to be good, but banding crews on the breeding grounds observed very few goslings. The Fall Productivity Survey recorded only 1.5% young. It may be necessary to target the

Spring Satellite Survey toward specific brant breeding areas to increase accuracy. Factors other than weather (e.g. predation, spring body condition) may need to be considered in production models.

Responsibility: Canadian Wildlife Service
U.S. Fish and Wildlife Service
Atlantic Flyway Council

Task I.B.6: Evaluate active and inactive surveys to determine which provide the most critical information for managing Atlantic brant.

The High-Arctic Goose (conducted in June), Submerged Aquatic Vegetation (October), and Spring Satellite Surveys have been discontinued. The reliability of the Mid-winter (January) and Productivity (November) surveys are believed to be good for brant but have not been assessed. Limited resources dictate that we collect the data that provide the information most important for management.

Responsibility: All cooperating agencies.

OBJECTIVE II: Maintain existing Atlantic brant habitat on breeding, migration, and wintering grounds.

Rationale: The Atlantic brant population and resultant societal benefits cannot be maintained without habitat. Breeding habitats are in remote areas, but could be threatened by resource extraction activities. Excessive grubbing by lesser snow geese may damage brood-rearing areas. Migration and wintering habitats are likely to be affected by human development and disturbance. Several studies (Ebbinge et al. 1982, Ankney 1984, Vangilder et al.1986, Ebbinge and Spaans 1995) provide evidence that energy acquired on staging grounds is important for reproductive success in brant.

Strategy II.A: Identify, evaluate, monitor, and protect important habitat areas used by Atlantic brant.

Task II.A.1: Investigate factors affecting the quality of breeding habitats for production and use. Document and assess effects of snow goose overpopulation on Atlantic brant breeding habitats.

Responsibility: Canadian Wildlife Service

Task II.A.2: Document and monitor important migration staging areas.

Responsibility: Atlantic Flyway Council
Canadian Wildlife Service
U.S. Fish and Wildlife Service

Task II.A.3: Document annual availability of winter food and its effect on brant body condition, habitat use, and survival.

Responsibility: U.S. Fish and Wildlife Service
U.S.G.S. Biological Resources Division
Atlantic Flyway Council

Task II.A.4: Develop or improve remote sensing or other techniques necessary to evaluate the extent and quality of marine forage plants important to Atlantic brant (Reed et al. 1998:23).

Responsibility: All cooperating agencies.

Task II.A.5: Conduct long-term monitoring of forage plants at staging and wintering areas (Reed et al. 1998:23).

Responsibility: All cooperating agencies.

OBJECTIVE III: Provide for human use consistent with the Management Plan goal.

Rationale: Atlantic brant are valued for viewing, photography, subsistence, and sport hunting.

Task III.A.1: Provide for viewing, photography, educational and other aesthetic uses of brant.

Responsibility: All cooperating agencies.

Task III.A.2: Provide for subsistence and sport harvest that is consistent with the Management Goal.

The current Hunt Plan explicitly lays out regulatory packages for sport harvest in the U.S. under various indices of population abundance. In Canada, because the average annual sport harvest is a few hundred birds, only extreme changes in abundance will trigger regulatory changes, and such changes would also be extreme. Under these extreme conditions, Canadian aboriginal people will also be asked to reduce the subsistence harvest.

Responsibility: All cooperating agencies

OBJECTIVE IV: Limit nuisance and depredation problems associated with Atlantic brant use of crops, golf courses, parks, and lawns.

Responsibility: USDA Wildlife Services, U.S. Fish and Wildlife Service, affected states.

OBJECTIVE V: Conduct research to improve our understanding of Atlantic brant, their population dynamics, and their relationships with habitat, the environment, and harvest.

Rationale: An improved understanding of brant biology will reduce the uncertainty currently associated with brant management and lead to a greater predictive ability, allowing managers to maximize use while minimizing risk. The literature base for Atlantic brant is considerably smaller than that for the Pacific black brant (*B. b. nigricans*), and is particularly lacking in studies using modern techniques. At present it appears that little research is being conducted on Atlantic brant. Research that addresses the topics in the Atlantic Brant Research Plan (Section 3) will be useful for brant management.

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SECTION 2.

ATLANTIC BRANT HUNT PLAN

Harvest Management Review

From 1933 to 1952 harvest of Atlantic brant was prohibited in the Atlantic Flyway (Rogers 1979). Seasons were closed in response to a population decline thought to have been triggered by the disappearance of eelgrass (*Zostera marina*), an important winter food of brant along the Atlantic Coast prior to 1933 (Cottam 1935, Cottam et al. 1944). The season was reopened during the fall of 1952.

The first four seasons (1952-1953 to 1955-1956) were from 10 to 30 days in length with a daily bag of 3 to 6 birds. The seasons were then increased to 60 or 70 days in length and bag limits were set at 6 birds per day. These regulations were maintained throughout the late 1950s and 1960s (Tables 1, 2). Under these conditions the Atlantic brant population varied about an average of 180,000 birds (SD = 45,000) and sustained a mean annual harvest of 21,000 (SD = 8,800) (Penkala et al. 1978). During the early 1970's the population declined severely (Table 1) because of poor reproduction, winter mortality, and high harvest. Hunting seasons were only held sporadically as the population fluctuated at a reduced level during this period (Tables 1, 2).

In 1977 the Snow Goose Brant and Swan Subcommittee of the Atlantic Flyway Council Technical Section (AFCTS) developed the Minimum Population Level (MPL) system for brant harvest management. Under the original MPL system, the mid-winter survey (Table 3) estimate of brant from the previous January would have to be at least 80,000 birds for a hunting season to be held. This lower limit was later revised to 100,000 birds. The subcommittee continued working with the MPL system which eventually became the Population Level (PL) system. Under the PL system the subcommittee proposed conservative hunting regulations (30 days/2 birds) when brant populations were less than 130,000 and liberal regulations (50/4) when populations were at high population levels (Hindman and Ferrigno 1990). This system was used by the subcommittee to formulate their harvest recommendations, however it was never formally endorsed by the AFCTS, AFC, or the U. S Fish and Wildlife Service (USFWS).

An interim hunt plan was established in 1992 and remained in effect through the 2001-02 season. That hunt plan calls for a closed season when the MWS estimate is <100,000; a 30-day, 2-bird season when 100,000 < MWS < 125,000; a 50-day, 2-bird season when 125,000 < MWS

< 150,000; and a 50-day, 4-bird season when MWS > 150,000. These regulations were implemented as long as "Productivity, food supply, age structure, or other factors do not preclude" them.

The USFWS position on brant harvest had been that it is important to reduce or restrict hunting when brant populations are under 150,000 (Rogers 1979). The North American Waterfowl Management Plan population objective for Atlantic brant is 124,000 (U.S. Fish and Wildlife Service et al. 1998).

Harvest rate indices for the United States are generally below 20% [harvest/(harvest + mid-winter), Tables 3, 4, 5]. At that level sport hunting does not appear limiting. The exception is the hunting season of 1971-72, when harvest is estimated to have removed nearly 50% of the population. Anecdotal information suggests that this very large harvest occurred because a severe shortage of sea lettuce forced brant to seek food on the salt marshes rather than the bays, making them much more susceptible to harvest.

Sport hunters in Canada take very few Atlantic brant. The average annual sport harvest since 1975 was about 800 birds. Canadian native subsistence harvest is more important. Hindman and Ferrigno (1990) reported "a small subsistence harvest of brant occurs on Hudson and James Bays, Quebec that rarely exceeds 1,000 birds." However, Reed (1991) estimated the mean annual aboriginal subsistence harvest of brant in James Bay to be 6,420 for the years 1972-73 through 1978-79. There was a voluntary reduction in native harvest following the severe winter die-offs of 1976-77 and 1977-78 and a more realistic estimate of native harvest may be 7,600 brant per year, the mean estimated harvest of the remaining three years (A. Reed, Canadian Wildlife Service, personal communication). An additional few hundred are taken annually by aboriginal hunters in western James Bay, and in the Baffin and Keewatin regions of Nunavut.

During the years when summer weather conditions in the arctic are unfavorable for breeding, fall populations are composed primarily of adult and sub-adults. Few young are hatched during those poor breeding years, therefore, few new breeders enter the adult age class when that cohort matures three years later. When several years of poor reproduction occur consecutively, any bird harvested is a potential breeder. Under these conditions, restrictive regulations are needed to allow population recovery. During the first few years of recovery from a population low caused by sequential production failures, many of the birds in the population

will be sub-adults, incapable of breeding that year. Over harvest at these times could hinder population recovery. Conversely, when the population is at a higher level and good production is forecast, opportunities for harvest should be expanded. The lack of a reliable production forecast at the July regulations meeting is a major stumbling block in setting appropriate harvest regulations for Atlantic brant.

Atlantic Brant Harvest Goal

To provide for sport hunting opportunity and subsistence harvest requirements for Atlantic brant that are consistent with maintenance of a viable population throughout its range.

Objectives

1. *Maintain desired populations*, i.e. ensure that hunting mortality in the Atlantic Flyway does not cause the brant population to remain below the established population goal;
2. *Maximize hunting opportunity*, i.e. maximize the number of days when brant hunters can go afield with a minimum daily bag of two birds in United States regulations;
3. *Keep regulations simple*, minimize the complexity of restrictions within the regular total daily bag; and
4. *Learn from experience*, i.e. increase our understanding of how hunting regulations affect hunting activity, harvest rates, and brant populations.

Harvest Strategies

As with the interim hunt plan, harvest regulations were developed by factoring together long-term productivity rates (Table 1) with harvest information obtained at different regulation levels (Table 2). The Brant Population Model (Table 5) was also considered when developing these strategies. These different strategies give consideration for recovery from low populations and for taking advantage of additional harvest opportunity at high populations. This harvest strategy differs from the interim hunt plan when brant populations exceed 150,000.

STRATEGY 1

A closed hunting season will be considered when the mid-winter survey estimate for brant is below 100,000. Aboriginal and sport hunters in Canada will be advised of the situation and requested to consider reducing their harvests.

STRATEGY 2

A sport hunting season consisting of 30 days and a 2 bird bag will be considered when the mid-winter survey estimate is between 100,000 and 125,000, if productivity, food supply, age structure, or other factors do not preclude it.

STRATEGY 3

A sport hunting season of 50 days and a 2 bird bag will be considered when the mid-winter survey estimate is between 125,000 and 150,000, if productivity, food supply, age structure, or other factors do not preclude it.

STRATEGY 4

A sport hunting season of 60 days and a 3 bird bag will be considered when the mid-winter survey estimate is between 150,000 and 200,000, if productivity, food supply, age structure, or other factors do not preclude it.

STRATEGY 5

A sport hunting season of 60 days and a 4 bird bag will be considered when the mid-winter survey estimate is greater than 200,000, if productivity, food supply, age structure, or other factors do not preclude it.

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SECTION 3.

ATLANTIC BRANT RESEARCH PLAN

Objective: Conduct research to improve our understanding of Atlantic brant, their population dynamics, and their relationships with habitat, the environment, and harvest.

Purpose

A good understanding of a species' biology and ecology is critical to the proper management of that species, especially for those that are hunted. Although little is known about the population ecology, vital rates, habitat use and requirements, or current migratory pathways and timing, little recent research has been conducted on Atlantic brant. The literature base for Atlantic brant is considerably smaller than that for the Pacific black brant (*B. b. nigricans*), and is particularly lacking in studies using modern techniques.

This plan's goal is to focus researcher's efforts by providing a comprehensive overview of Atlantic brant research needs, prioritizing needs, and identifying projects that will help fulfill those needs. Undoubtedly, as we begin to fill in some of the blanks in Atlantic brant biology, new questions will arise, and this plan should be revised as the situation warrants. The Action Plan strategies or tasks that each research topic is related to are listed in parentheses.

Information Needs and Research Topics

1. Annual assessment of production

Develop an annual assessment of production that can be completed in time for July regulations meetings. This is especially important for avoiding over-harvest of mature birds during "bust" production years. During the early 1980s the USFWS developed a model to predict age ratios in the harvest based on variables derived from advanced very high resolution radiometer satellite data. The model appeared to perform well when initially developed, but during the late 1990s model performance suffered. For example, in 1999 the model predicted better than average production and hunting frameworks were set for a 50-day, 4-bird season. However, banding crews on the breeding grounds observed few family groups or young. Based on this information the bag limit was decreased to 2 birds. The November productivity survey found only 1.5% young in the fall flight (U.S. Fish and Wildlife Service 2000). Poor performance of this model stems from the fact that in the late 1990s input data were often outside of the range of the data used to develop the model. The model input data also did not capture severe weather events which could

reduce production (G. Smith, Chief, Population and Habitat Assessment Section, U.S. Fish and Wildlife Service, personal communication). Another potential problem with the model is that it used harvest age ratios as its index to production (P. Castelli, New Jersey Division of Fish and Wildlife, personal communication). Traditional harvest surveys do not assess brant harvest well (Geissler 1990) and corrections for potential differential vulnerability are not available. Finally, satellite imagery used in the brant model reflected average conditions on Baffin Island, while brant nest only on a very small portion of Baffin.

It may be possible to modify the existing model to improve performance, however conducting a new model development exercise with improved databases is more desireable (G. Smith, personal communication). A production index is available from the November surveys conducted in the mid-Atlantic states. These data provide a more accurate index to production than do the harvest age ratios used in the previous model. Satellite imagery focused on the few coastal habitats used by breeding brant would provide a more meaningful assessment of breeding habitat conditions than the broad brush approach used previously. Automated weather station data may be available to assess the effects of severe weather events. (I.A)

a. Breeding habitat quality

Determine factors that affect the quality and use of breeding habitats. Any effects of snow goose (*Chen caerulescens*) overpopulation on brant breeding habitats should be documented and assessed. (II.A.1)

b. Staging area research

Nutrient reserves acquired on staging areas may be critical to brant nest success (Ebbinge 1982, Vangilder et al. 1986, Ebbinge 1989, Ebbinge and Spaans 1995). The locations of migration and staging areas along the Atlantic Coast, St. Lawrence River, and James Bay need to be documented. Factors (e.g. food availability, anthropogenic disturbance, etc) that affect the quality of habitat on these areas remains unknown as does their status (e.g. degradation or loss).

c. *Develop new remote sensing techniques to evaluate breeding and staging habitat conditions*

Atlantic brant nest and stage in remote areas that are not surveyed easily using conventional methods. To the extent that conditions in these areas affect production, reliable remote-sensed (satellite) methods should be developed to produce an accurate index to production.

2. *Annual survival*

Determine annual survival of brant each year and document important sources of mortality. Banding probably is the most appropriate method to address this topic. Attempt to partition annual survival into periods such as spring migration, breeding, fall migration, and wintering. (I.A)

3. *Harvest rate and influence of hunting regulations*

Determine the harvest rate associated with various hunting regulation packages. Assess the influence of ancillary factors such as timing of the season, length and overlap of associated duck seasons, winter weather, and population structure. Determining affect of various factors on harvest rates of brant will be a long-term project, as it will not be possible to manipulate natural factors and it is unlikely that harvest regulations will be manipulated solely to speed our learning. These issues probably would be addressed best by a long-term banding project or projects. (I.A, I.B, III.A.2)

4. *Evaluate fidelity to and associations between breeding and wintering areas*

Assess the fidelity of brant to breeding and wintering areas and determine whether associations of specific breeding areas to specific wintering areas exist and their strength. Examination of necklace types on the breeding (Abraham et al. 1983) and wintering (Vangilder and Smith 1985) grounds indicates that some association may exist. Genetic analysis of brant collected by Vangilder and Smith (1985) in New York, New Jersey, and Virginia indicate some non-random migration between wintering and nesting areas or reduction in gene flow on wintering or migration grounds (Novak et al. 1989:162).

5. *Wintering ecology*

   Investigate winter ecology, including: foods and foraging ecology, annual food availability (and its ultimate effect on body condition), habitat use, and the effects of disturbance. (II.A.3, B4)

6. *Evaluate and improve the Submerged Aquatic Vegetation Survey*

   Determine if existing sea lettuce survey provides adequate information concerning winter food supply and develop other techniques to monitor forage plants if the current survey is inadequate. (II.A.3, B4)

7. *Develop a spring body condition index*

   Develop a body condition index of brant taken just prior to spring migration to serve as an indicator of reproductive potential. However, some work (Ebbinge 1982, Vangilder et al. 1986, Ebbinge 1989, Ebbinge and Spaans 1995) indicates that nutrient reserves acquired on staging areas may be more important for reproductive success than winter condition. For example, good body condition might allow brant to arrive in excellent physiological condition to breed, but bad weather could still limit breeding success. However, poor body condition might preclude good breeding success even if all other factors are positive. If this is the case, a condition index of this type could predict only the potential for breeding success, and other factors will need to be considered to predict actual success. (I.A.)

8. *Establish geographic limits of the breeding range*

   Clearly establish the western limit of the breeding range with further work on Prince of Wales and King William Islands, on the Boothia Peninsula, and in Committee Bay. (I.A)

9. *Define the conditions of "productivity, food supply, age structure, or other factors" that would preclude implementing harvest packages prescribed in the Hunt Plan for a given population level recorded in the Mid-winter Waterfowl Survey.* (I.A., III.A.2)

   Currently, the factors and conditions that are used to modify the harvest regulation prescriptions for the United States are vaguely stated, subjective, and open to interpretation. Explicit definition of these factors can lead to more objective criteria for implementing more restrictive harvest regulations than are called for by the MWS index, or to research into those factors, their effects on brant populations, and critical levels of those factors.

10. *Develop a harvest survey to estimate aboriginal subsistence harvest in Canada.*
    Unlike Canadian sport harvest, aboriginal subsistence harvest probably makes up a non-trivial portion of Atlantic brant hunting mortality. Accounting for this source of hunting mortality is important to a better understanding of Atlantic brant population dynamics and the effects of hunting regulations and hunting on the population. (I.B.4)
11. *Population model development*
    Develop a model or models to predict changes in the Atlantic brant population in response harvest management, habitat, and other biotic and abiotic factors determined to be important to population dynamics. This topic is listed last because its completion will rely heavily on information gained from other research listed. However, the framework for these models can be built and then filled in as they become available from other projects. (I.A, IV)

Projects and Tasks

Complete the current pre-season banding study.

Canadian Wildlife Service (CWS) crews have been banding geese on the Great Plain of the Koukdjuak, Baffin Island, Nunavut, since 1991. Atlantic brant were opportunistically banded in low numbers as part of these operations. In 1998 funding was secured to increase the number of brant banded to 600 to 800 per year. Poor weather conditions limited the number of brant banded in 1998, and early molting caused by a production failure meant that brant could not be captured in 1999. Results were better in 2000, with 1,029 brant banded on Baffin Island , and in 2001, with about 600 brant banded on Baffin Island and 1,040 banded on Southampton Island. Funding for the banding has been provided by the Atlantic Flyway Council and the Canadian Wildlife Service.

Conduct ongoing radio/satellite telemetry project.

In 2001, researchers in the U.S. and Canadian Atlantic Flyway initiated a combined VHF and satellite telemetry study of Atlantic brant distribution. The goal of the study is to "To improve knowledge about Atlantic brant seasonal movement patterns, migration chronology, critical staging areas, important breeding colonies, and to develop and refine GIS models to describe and predict locations of breeding habitats." The study should provide information concerning the timing of migration and use of key staging areas, a description of the GIS

breeding habitat signature and distribution of Atlantic brant, and goose use and distribution along eelgrass beds in James Bay during June 2002. In addition, the results will be used in habitat protection and will serve as pilot data to improve the design of future studies.

Design and implement a full-fledged satellite telemetry study of annual Atlantic brant movements.

Satellite telemetry has proved to be an valuable tool in tracking the large-scale movements of waterfowl (e.g. Blouin et al. 1999, Robert et al. 2000, Malecki et al. 2001) and other birds (e.g. Hatch et al. 2000, Kjellen et al. 2001). A similar study of European brant (Clausen and Bustnes 1998, *http://www.dmu.dk/coastalZoneEcology/satellite/index_uk.htm*) revealed unknown spring migration patterns of brant wintering in Denmark.

A large-scale satellite telemetry study could shed light on changing Atlantic brant spring migration patterns and on fall migration pathways, which have not been described. This type of study will also address issues of staging and breeding area locations and use.

Design and implement radio telemetry studies of Atlantic brant wintering home range, habitat use, time budgets, and survival.

Radio-telemetry-based estimates of winter survival may provide a basis to begin to partition annual survival among seasons. Telemetry studies will also provide a better understanding of current habitat use and critical habitat for wintering brant.

Determine the cause and extent of eelgrass decline in James Bay and effect on staging brant.

Research has shown that nutrition and food supply on spring staging grounds is critical to brant breeding success. It appears that most if not all Atlantic brant now stage on James Bay during spring and failure of this preferred food source could severely limit breeding success.

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SECTION 4.
CURRENT DATABASES

Figure 1: Distribution Map

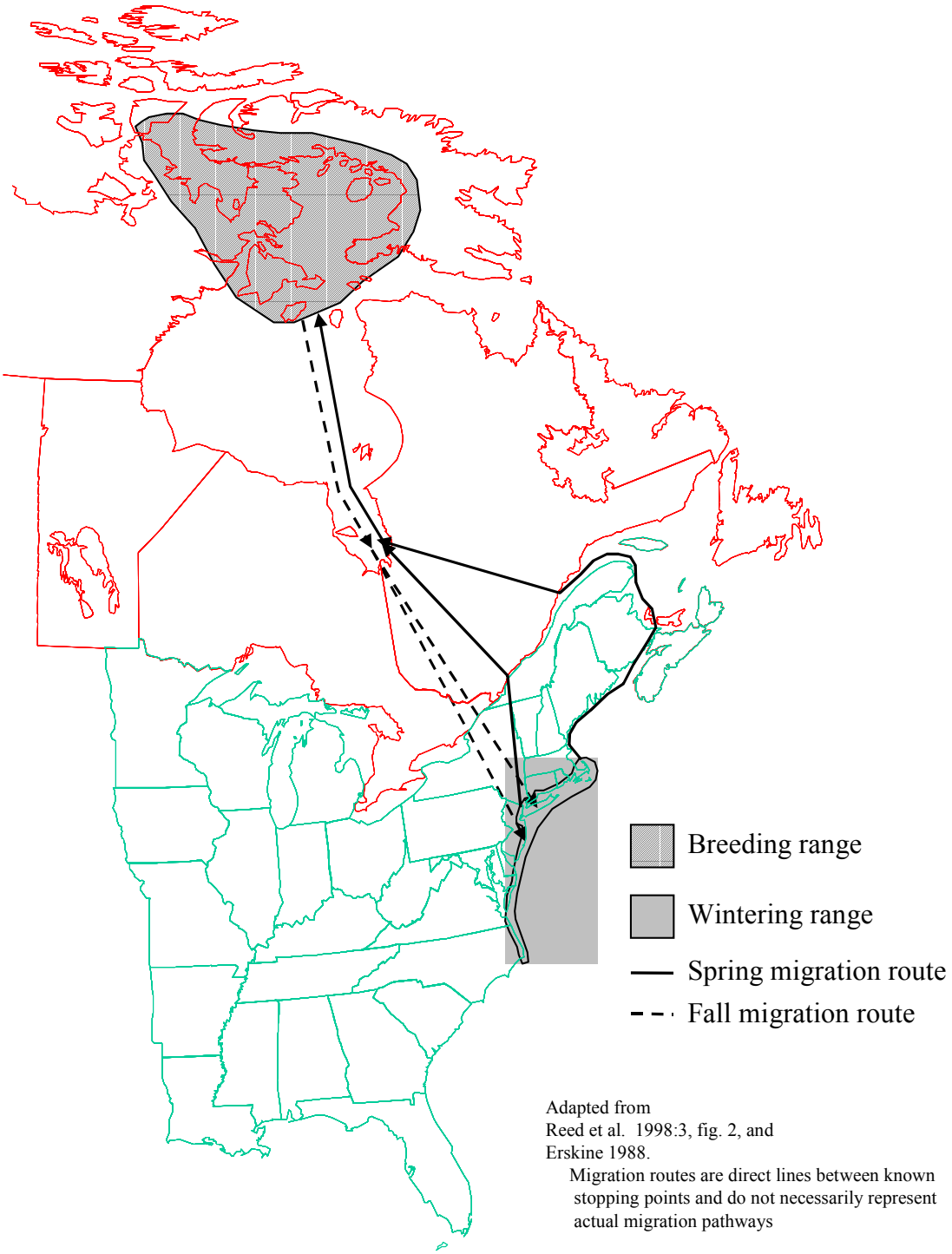

Table 1. Historical survey data for Atlantic brant, 1948-2002.

Year	Mid-winter Index (January) [a]	Productivity survey (November) [b]	U.S. Harvest (Sept.- Feb.)			
			USFWS estimate	Age ratio	Young	Adult/subadult
1948	57,810	ND [c]	ND	ND	.	.
1949	75,435	ND	ND	ND	.	.
1950	74,150	ND	ND	ND	.	.
1951	112,568	ND	ND	ND	.	.
1952	103,506	ND	3,321	ND	.	.
1953	155,262	ND	3,965	ND	.	.
1954	218,153	ND	9,176	ND	.	.
1955	183,825	ND	7,382	ND	.	.
1956	164,385	ND	16,100	ND	.	.
1957	162,036	ND	23,469	ND	.	.
1958	211,057	ND	14,549	ND	.	.
1959	217,426	ND	35,383	ND	.	.
1960	238,338	ND	34,929	ND	.	.
1961	265,688	ND	19,129	ND	.	.
1962	124,490	ND	26,906	0.51	9,087	17,819
1963	173,494	ND	34,049	0.8	15,133	18,916
1964	182,700	ND	30,008	0.44	9,169	20,839
1965	185,982	ND	13,781	0.31	3,261	10,520
1966	171,850	ND	32,560	1.38	18,879	13,681
1967	219,024	ND	22,743	0.48	7,376	15,367
1968	213,450	ND	24,350	0.09	2,011	22,339
1969	130,831	0.304	18,387	1.18	9,953	8,434
1970	106,511	0.390	25,636	1.02	12,945	12,691
1971	150,965	0.057	66,753	0.15	8,707	58,046
1972	73,242	0.0008	0	N/A	0	0
1973	40,835	0.594	195	1.00	98	98
1974	87,653	0.121	235	0.00	0	235
1975	88,408	0.442	30,396	1.05	15,569	14,827
1976	127,028	0.101	0	N/A	0	0
1977	73,605	0.295	572	2.87	424	148
1978	42,765	0.053	553	0.38	152	401
1979	43,554	0.399	454	1.03	230	224
1980	69,243	0.337	100	0.00	0	100
1981	97,028	0.179	33,719	0.26	6,958	26,761
1982	104,532	0.235	23,584	0.53	8,170	15,414

Table 1 (cont.). Historical survey data for Atlantic brant, 1948-2000.

Year	Mid-winter Index (January) [a]	Productivity survey (November) [b]	U. S. Harvest (Sept.- Feb.)			
			USFWS estimate	Age ratio	Young	Adult/subadult
1983	123,465	0.323	34,404	0.56	12,350	22,054
1984	127,317	0.213	48,299	0.49	15,884	32,415
1985	146,325	0.158	31,434	0.23	5,878	25,556
1986	110,368	0.037	9,383	0.07	614	8,769
1987	109,443	0.265	8,242	0.56	2,959	5,283
1988	131,183	0.267	22,434	0.77	9,759	12,675
1989	137,939	0.210	26,148	0.45	8,115	18,033
1990	135,444	0.109	14,556	0.24	2,817	11,739
1991	147,744	0.245	12,409	0.57	4,505	7,904
1992	184,780	0.022	14,124	0.08	1,046	13,078
1993	100,627	0.212	10,489	0.73	4,426	6,063
1994	157,159	0.101	13,774	0.21	2,391	11,383
1995	148,172	0.216	15,586	0.70	6,418	9,168
1996	105,903	0.154	5,282	0.14	649	4,633
1997	129,062	0.174	18,239	0.43	5,484	12,755
1998	137,974	0.241	9,348	0.56	3,356	5,992
1999	171,628	0.015	9,811	0.10	892	8,919
2000	157,156	0.251	18,805	1.17	10,136	8,669
2001	145,261	0.247	31,231	0.53	10,766	20,465
2002	181,631	-- [d]	--	--	--	--

[a] Estimates for the period 1948-1980 taken from Table 1 of Kirby and Obrecht 1982:336
[b] Proportion of fall flight that is young of the year
[c] No data
[d] Not yet available

Table 2. Summary of Atlantic brant harvest under various regulations, 1958-59 through 2000-01.

Season length/bag limit	Hunting season	Previous midwinter	% young in fall flight	Harvest			
				Total	Age ratio (y:a)	Young	Adults
30/2	1981-82	97,028	17.9	33,719	0.26	6,958	26,761
	1982-83	104,532	23.5	23,584	0.53	8,170	15,414
	1986-87	110,368	3.7	9,383	0.07	614	8,769
	1987-88	109,443	26.5	8,242	0.56	2,959	5,283
	1993-94	100,627	21.2	10,489	0.73	4,426	6,063
	1996-97	105,903	15.4	5,282	0.14	649	4,633
	Mean	104,650	18.0	15,117	0.38	3,963	11,154
	SE	2,094	3.3	4,531	0.11	1,292	3,513
30/4	1975-76	88,408	44.2	30,396	1.05	15,569	14,827
50/2	1983-84	123,465	32.3	34,404	0.56	12,350	22,054
	1988-89	131,183	26.7	22,434	0.77	9,759	12,675
	1989-90	137,939	21.0	26,148	0.45	8,115	18,033
	1990-91	135,444	10.9	14,556	0.24	2,817	11,739
	1991-92	147,744	24.5	12,409	0.57	4,505	7,904
	1992-93	184,780	2.2	14,124	0.08	1,046	13,078
	1994-95	157,159	10.1	13,774	0.21	2,391	11,383
	1995-96	148,172	21.6	15,586	0.70	6,418	9,168
	1997-98	121,465	17.4	18,239	0.43	5,484	12,755
	1998-99	137,974	24.1	9,348	0.56	3,356	5,992
	1999-2000	171,628	1.5	9,811	0.10	892	8,919
	2000-2001	157,156	25.1	18,805	1.17	10,136	8,669
	2001-2002	181,631	24.7	31,231	0.53	10,766	20,465
	Mean	146,105	18.6	18,528	0.49	6,003	12,526
	SE	5,056	2.7	2,194	0.08	1,081	1,363
50/4	1984-85	127,317	21.3	48,299	0.49	15,884	32,415
	1985-86	146,325	15.8	31,434	0.23	5,878	25,556
	Mean	136,821	18.55	39,867	0.36	10,881	28,986
	SE	9,504	2.75	8,433	0.13	5,003	3,430

Table 2 (cont.). Summary of Atlantic brant harvest under various regulations, 1958-59 through 2000-01.

Season length/bag limit	Hunting season	Previous midwinter	% young in fall flight	Harvest			
				Total	Age ratio (y:a)	Young	Adults
60/6	1958-59	211,057	n.d.	14,549	n.d.	n.d.	n.d.
60/6	1959-60	217,426	n.d.	35,383	n.d.	n.d.	n.d.
60/6	1960-61	238,338	n.d.	34,929	n.d.	n.d.	n.d.
60/6	1961-62	265,688	0.03	19,129	n.d.	n.d.	n.d.
60/6	1962-63	124,490	22.5	26,906	n.d.	n.d.	n.d.
	Mean	211,400	11.3	26,179			
	SE	23,730	11.2	4,164			
70/6	1963-64	173,494	43.5	34,049	n.d.	n.d.	n.d.
70/6	1964-65	182,700	32.5	30,008	n.d.	n.d.	n.d.
70/6	1965-66	185,982	23.7	13,781	n.d.	n.d.	n.d.
70/6	1966-67	171,850	51.2	32,560	n.d.	n.d.	n.d.
70/6	1967-68	219,024	41.9	22,743	n.d.	n.d.	n.d.
70/6	1968-69	213,450	0.07	24,350	n.d.	n.d.	n.d.
70/6	1969-70	130,831	30.4	18,387	1.18	9,953	8,434
70/6	1970-71	106,511	39.0	25,636	1.02	12,945	12,691
70/6	1971-72	150,965	5.7	66,753	0.15	8,707	58,046
	Mean	170,534	29.8	29,807	0.78	10,535	26,390
	SE	12,161	5.8	5,103	0.32	1,258	15,875
Closed	1972-73	73,242	0.08	0	n.d.	0	0
Closed	1973-74	40,835	59.4	195	1.00	98	98
Closed	1974-75	87,653	12.1	235	0.00	0	235
Closed	1976-77	127,003	10.1	0	n.d.	0	0
Closed	1977-78	73,605	29.5	572	2.87	424	148
Closed	1978-79	42,740	5.3	553	0.38	152	401
Closed	1979-80	43,554	39.9	454	1.03	230	224
Closed	1980-81	69,242	33.7	100	0.00	0	100
	Mean	69,734	23.8	264	0.88	113	151
	SE	10,245	7.2	83	0.44	54	47

[a] No data.

Table 3. Numbers of brant observed during the midwinter waterfowl survey in the Atlantic Flyway, 1948-2002.[a]

Year	ME	VT	NH	MA	CT	RI	NY	PA	WV	NJ	DE	MD	VA	NC	SC	GA	FL	Total
1948	0	0	0	60	0	0	0	0	0	43,500	0	13,750	0	500	0	0	0	57,810
1949	0	0	0	0	35	0	0	0	0	57,300	0	9,200	7,400	1,500	0	0	0	75,435
1950	0	0	0	0	0	0	400	0	0	63,400	0	8,350	2,000	0	0	0	0	74,150
1951	4	0	0	0	0	4	0	0	0	82,700	310	3,050	24,100	2,400	0	0	0	112,568
1952	0	ND [b]	1	0	0	1	ND	0	0	90,000	0	4,850	8,500	154	0	0	0	103,506
1953	0	0	0	282	0	0	2,615	0	0	141,800	0	2,100	8,300	165	0	0	0	155,262
1954	0	0	0	735	0	0	17,198	0	0	162,600	1,600	32,170	3,000	850	0	0	0	218,153
1955	0	0	0	500	0	0	19,050	0	0	151,000	0	75	12,700	500	0	0	0	183,825
1956	0	0	0	0	0	0	25,350	0	0	108,100	450	11,300	18,750	435	0	0	0	164,385
1957	0	0	0	14	0	0	9,620	0	0	143,550	342	3,700	4,400	410	0	0	0	162,036
1958	0	0	0	50	0	0	14,550	0	0	184,500	946	7,350	3,486	175	0	0	0	211,057
1959	0	0	0	0	0	0	34,300	0	0	175,400	4,266	840	1,660	960	0	0	0	217,426
1960	0	0	0	75	0	0	33,400	1	0	183,200	3,840	972	16,350	500	0	0	0	238,338
1961	0	0	0	100	0	0	39,375	30	0	200,830	12,853	2,900	9,100	500	0	0	0	265,688
1962	0	0	0	505	0	0	28,680	51	0	88,750	804	800	4,700	200	0	0	0	124,490
1963	0	0	0	0	0	0	52,839	0	0	109,000	5,555	400	5,500	200	0	0	0	173,494
1964	0	0	0	960	0	0	23,840	0	0	143,550	9,200	1,900	2,900	350	0	0	0	182,700
1965	0	0	0	12	0	0	10,900	0	0	165,100	1,200	1,400	7,350	20	0	0	0	185,982
1966	0	0	0	300	0	0	17,500	0	0	151,600	1,100	0	1,350	0	0	0	0	171,850
1967	0	0	0	50	0	0	23,274	0	0	189,050	2,350	100	4,200	0	0	0	0	219,024
1968	0	0	0	75	0	0	15,375	0	0	182,000	1,500	600	13,500	300	100	0	0	213,450
1969	0	0	0	430	1	0	19,950	0	0	78,200	3,050	1,500	27,400	300	0	0	0	130,831
1970	0	0	0	6	0	0	6,705	0	0	96,100	800	300	1,900	700	0	0	0	106,511
1971	0	0	0	65	0	0	12,805	0	0	129,400	1,395	400	6,900	0	0	0	0	150,965
1972	0	0	0	2,925	0	0	14,852	0	0	48,600	665	3,200	2,800	200	0	0	0	73,242
1973	0	0	0	325	0	0	10,581	0	0	22,600	275	400	6,454	200	0	0	0	40,835
1974	0	0	0	332	0	0	21,436	0	0	46,350	1,435	1,200	16,700	200	0	0	0	87,653
1975	0	0	0	523	40	0	24,045	0	0	55,200	500	0	7,700	400	0	0	0	88,408
1976	0	0	0	1,128	0	0	17,040	0	0	99,000	1,135	1,600	6,900	200	0	25	0	127,028
1977	0	0	0	2,348	0	0	13,622	0	0	26,900	6,335	2,200	21,700	500	0	0	0	73,605
1978	0	0	0	3,845	135	136	8,936	0	0	14,600	2,278	1,600	10,810	400	25	0	0	42,765
1979	0	0	0	760	0	8	8,211	0	0	31,890	885	100	1,700	0	0	0	0	43,554

Table 3 (cont.). Numbers of brant observed during the midwinter waterfowl survey in the Atlantic Flyway [a]

Year	ME	VT	NH	MA	CT	RI	NY	PA	WV	NJ	DE	MD	VA	NC	SC	GA	FL	Total
1980	0	0	0	3,282	3	0	18,912	0	0	31,570	3,269	2,300	8,406	1,500	0	1	0	69,243
1981	0	0	0	3,992	80	212	16,653	0	0	53,605	2,817	400	11,769	7,500	0	0	0	97,028
1982	0	0	0	1,707	300	0	14,925	0	0	63,000	2,600	1,000	17,500	3,400	0	0	100	104,532
1983	0	0	0	1,415	50	0	12,600	0	0	76,100	100	3,800	28,400	1,000	0	0	0	123,465
1984	0	0	0	2,407	200	310	2,500	0	0	89,800	1,400	1,400	29,000	300	0	0	0	127,317
1985	0	0	0	1,130	0	360	8,715	0	0	91,500	3,200	2,000	37,020	2,400	0	0	0	146,325
1986	0	0	0	935	720	100	4,503	0	0	69,400	400	0	33,810	500	0	0	0	110,368
1987	0	0	0	2,290	4	0	16,144	0	0	80,800	0	0	10,155	50	0	0	0	109,443
1988	0	0	0	935	2	227	15,710	0	0	89,400	1,000	100	23,330	479	0	0	0	131,183
1989	0	0	0	2,265	370	0	10,873	0	0	90,300	1,800	3,819	26,765	1,745	2	0	0	137,939
1990	0	0	0	985	175	500	18,950	0	0	89,000	1,965	2,853	18,511	2,420	85	0	0	135,444
1991	0	0	0	1,355	35	0	21,925	0	0	98,200	300	1,450	22,774	1,705	0	0	0	147,744
1992	0	0	0	920	160	100	22,321	0	0	144,315	357	581	12,988	3,038	0	0	0	184,780
1993	12	0	0	2,305	70	900	24,937	0	0	49,774	350	890	21,338	27	24	0	0	100,627
1994	10	0	0	1,715	0	0	12,919	0	0	122,260	1,300	1,460	16,357	1,138	0	0	0	157,159
1995	0	0	0	655	0	825	22,659	0	0	116,310	1,320	1,150	5,253	0	0	0	0	148,172
1996	13	0	0	1,035	185	1,500	13,941	0	0	75,065	4,050	1,272	8,036	806	0	0	0	105,903
1997 [c]	15	0	0	1,365	375	2,025	23,572	0	0	87,240	1,350	650	12,470	0	0	0	0	129,062
1998	0	0	0	1,856	6	2,740	37,782	0	0	67,285	0	1,980	26,325	0	0	0	0	137,974
1999	21	0	0	1,280	0	0	29,397	0	0	120,865	1,970	537	17,550	8	0	0	0	171,628
2000 [d]	0	0	0	2,365	132	1,010	17,874	0	0	120,225	0	400	15,150	0	0	0	0	157,156
2001 [d]	0	0	0	2,204	465	1,445	25,201	2	0	96,685	3,657	925	14,677	0	0	0	0	145,261
2002	0	0	0	3,025	500	940	37,675	0	0	124,590	0	535	14,355	0	0	0	11	181,631

[a] State and flyway values for the period 1948-1980 taken from Table 1 of Kirby and Obrecht 1982:336
[b] No data
[c] Estimates for NY based on change in Federation of NY State Bird Club Counts, 1996 to 1997.
[d] Estimates for some states and the Flyway are not comparable with other years. Estimates for portions of some states (2000: CT, NY; 2001: FL) based on previous 3-year average.

Table 4. Annual bias-adjusted state-level estimates of brant harvest in the Atlantic Flyway since 1952 for entire season and all U.S. waterfowl hunters (retrieved kill by state of duck stamp purchase through 1961 with species composition based on hunter reports; by state of harvest thereafter with species composition based on Parts Collection Survey).

Year	ME	VT	NH	MA	CT	RI	NY	PA	WV	NJ	DE	MD	VA	NC	SC	GA	FL	Total
1952	0	0	0	0	0	0	284	0	0	1,886	0	0	176	780	0	0	195	3,321
1953	0	0	0	99	120	0	2,125	0	0	1,621	0	0	0	0	0	0	0	3,965
1954	0	0	0	81	0	0	949	124	0	7,217	157	343	305	0	0	0	0	9,176
1955	55	0	0	289	43	0	1,491	0	0	4,486	494	135	336	53	0	0	0	7,382
1956	0	0	0	0	0	0	1,264	0	0	11,636	1,183	608	1,310	99	0	0	0	16,100
1957	51	0	0	196	0	27	3,673	90	0	14,941	0	323	1,201	2,967	0	0	0	23,469
1958	0	74	0	247	364	4	4,337	44	0	8,612	455	183	16	0	0	99	114	14,549
1959	18	0	32	120	42	153	9,428	1,020	0	20,918	1,516	1,294	148	657	37	0	0	35,383
1960	1,046	87	0	959	0	91	13,740	450	0	16,920	708	568	329	31	0	0	0	34,929
1961	46	46	15	273	17	0	4,899	333	0	12,741	111	131	320	197	0	0	0	19,129
1962	0	0	0	0	0	0	5,350	0	0	21,063	0	386	107	0	0	0	0	26,906
1963	0	0	0	226	0	0	6,568	0	0	24,910	375	0	1,970	0	0	0	0	34,049
1964	0	0	0	0	0	0	5,557	0	0	24,451	0	0	0	0	0	0	0	30,008
1965	0	79	0	0	0	0	3,026	0	0	10,530	0	101	45	0	0	0	0	13,781
1966	0	0	0	301	0	0	8,538	0	0	23,120	39	247	0	315	0	0	0	32,560
1967	0	41	0	36	286	0	3,120	0	0	18,755	130	201	87	87	0	0	0	22,743
1968	0	23	0	67	0	0	5,365	0	0	16,137	923	452	1,383	0	0	0	0	24,350
1969	0	255	81	93	116	0	2,948	0	0	13,671	0	448	775	0	0	0	0	18,387
1970	0	0	0	366	0	0	5,385	0	0	18,574	474	585	252	0	0	0	0	25,636
1971	0	0	0	74	46	0	20,007	305	0	42,350	396	494	3,081	0	0	0	0	66,753
1972	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	0	0	195	0	0	0	0	195
1974	0	0	0	0	0	0	235	0	0	0	0	0	0	0	0	0	0	235
1975	0	0	0	1,425	0	0	6,397	178	0	18,688	1,035	623	2,050	0	0	0	0	30,396
1976	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	443	129	0	0	0	572
1978	0	0	0	92	0	0	461	0	0	0	0	0	0	0	0	0	0	553
1979	0	0	0	0	0	0	230	0	0	0	0	224	0	0	0	0	0	454
1980	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	100
1981	0	0	0	2,146	0	29	19,624	0	0	8,227	564	1,043	2,086	0	0	0	0	33,719

Table 4 (cont). Annual bias-adjusted state-level estimates of brant harvest in the Atlantic Flyway since 1952 for entire season and all U.S. waterfowl hunters (retrieved kill by state of duck stamp purchase through 1961 with species composition based on hunter reports; by state of harvest thereafter with species composition based on Parts Collection Survey).

Year	ME	VT	NH	MA	CT	RI	NY	PA	WV	NJ	DE	MD	VA	NC	SC	GA	FL	Total
1982	0	0	0	552	0	184	10,874	0	0	9,124	326	1,597	575	352	0	0	0	23,584
1983	0	83	0	1,771	440	0	21,515	0	0	7,358	164	0	1,205	1,868	0	0	0	34,404
1984	0	304	0	2,467	1,561	67	20,307	0	0	22,095	0	705	604	189	0	0	0	48,299
1985	0	57	0	2,271	344	0	11,115	0	0	14,331	715	1,979	306	316	0	0	0	31,434
1986	0	167	0	176	223	25	3,183	0	0	5,609	0	0	0	0	0	0	0	9,383
1987	0	0	0	980	0	0	2,213	0	0	3,059	0	1,745	245	0	0	0	0	8,242
1988	0	255	0	745	0	69	4,369	0	0	9,805	1,010	4,449	1,732	0	0	0	0	22,434
1989	0	258	0	708	0	42	6,655	0	0	7,476	1,057	2,224	4,501	3,022	0	205	0	26,148
1990	0	0	0	768	0	0	4,974	0	0	5,256	92	1,398	2,068	0	0	0	0	14,556
1991	0	0	0	717	0	0	3,983	0	0	7,185	0	0	524	0	0	0	0	12,409
1992	0	0	0	478	206	63	2,958	107	0	6,916	74	1,038	2,141	143	0	0	0	14,124
1993	0	303	0	528	145	125	2,418	115	0	5,252	0	0	1,603	0	0	0	0	10,489
1994	0	0	0	145	0	1,022	1,189	0	0	6,600	460	1,611	2,613	134	0	0	0	13,774
1995	0	0	0	336	123	0	4,404	0	0	8,382	156	0	1,805	380	0	0	0	15,586
1996	0	397	0	91	0	0	1,047	0	0	2,700	0	0	973	74	0	0	0	5,282
1997	0	0	0	474	0	43	3,984	0	0	7,631	701	0	4,131	1,275	0	0	0	18,239
1998	0	0	0	173	0	38	1,591	0	0	5,647	0	292	1,153	454	0	0	0	9,348
1999	0	0	0	171	0	116	1,752	0	0	6,271	334	750	235	182	0	0	0	9,811
2000	0	0	172	348	331	21	6,462	0	0	5,032	525	964	4,038	912	0	0	0	18,805
2001[a]	87	210	0	1,386	878	457	4,642	71	0	21,469	0	428	1,604	0	0	0	0	31,231

[a] Preliminary

Table 5. Atlantic brant population model, 1969-2001.

Year (*t*)	Mid-winter inventory (N_t)	Fall flight: Proportion young $p_{(t)}$	Fall flight: Age ratio (y/o) ($A_{T,t}$)	Fall flight: No young ($F_{Y,t}$)	Fall flight: Total ($F_{T,t}$)	Fall harvest ($H_{T,t}$)	Winter natural survival (S')	Harvest rate[a]
1969	130,831	0.304	0.437	57,145	187,976	18,387	0.638	0.0978
1970	106,511	0.390	0.639	68,097	174,608	25,636	1.040	0.1468
1971	150,965	0.057	0.060	9,125	160,090	66,753	0.879	0.4170
1972	73,242	0.0008	0.001	59	73,301	0	0.557	0.0000
1973	40,835	0.594	1.463	59,744	100,579	195	0.873	0.0019
1974	87,653	0.121	0.138	12,066	99,719	235	0.889	0.0024
1975	88,408	0.442	0.792	70,029	158,437	30,396	1.029	0.1918
1976	127,003	0.101	0.112	14,268	141,271	0	0.521	0.0000
1977	73,605	0.295	0.418	30,799	104,404	572	0.412	0.0055
1978	42,740	0.053	0.056	2,392	45,132	553	0.979	0.0123
1979	43,554	0.399	0.664	28,915	72,469	454	0.962	0.0063
1980	69,242	0.337	0.508	35,195	104,437	100	0.931	0.0010
1981	97,074	0.179	0.218	21,165	118,239	33,719	1.315	0.2852
1982	104,500	0.235	0.307	32,101	136,601	23,584	1.129	0.1726
1983	123,600	0.323	0.477	58,970	182,570	34,404	0.890	0.1884
1984	127,300	0.213	0.271	34,453	161,753	48,299	1.378	0.2986
1985	146,325	0.158	0.188	27,458	173,783	31,434	0.802	0.1809
1986	110,368	0.037	0.038	4,241	114,609	9,383	1.054	0.0819
1987	109,443	0.265	0.361	39,459	148,902	8,242	0.941	0.0554
1988	131,183	0.267	0.364	47,784	178,967	22,434	0.901	0.1254
1989	137,939	0.210	0.266	36,667	174,606	26,148	0.937	0.1498
1990	135,444	0.109	0.122	16,569	152,013	14,556	1.092	0.0958
1991	147,744	0.245	0.325	47,943	195,687	12,409	1.019	0.0634
1992	184,780	0.022	0.022	4,157	188,937	14,124	0.583	0.0748
1993	100,627	0.212	0.269	27,072	127,699	10,489	1.359	0.0821
1994	157,159	0.101	0.112	17,656	174,815	13,774	0.932	0.0788
1995	148,172	0.216	0.276	40,823	188,995	15,586	0.619	0.0825
1996	105,903	0.154	0.182	19,278	125,181	5,282	1.020	0.0422
1997	121,465	0.174	0.211	25,587	147,052	18,239	1.094	0.1240
1998	137,974	0.241	0.318	43,810	181,784	9,348	1.003	0.0514
1999	171,628	0.015	0.015	2,614	174,242	9,811	0.928	0.0563
2000	151,177	0.251	0.335	50,661	201,838	19,331	0.809	0.0958
2001	145,261	0.247	0.328	47,649	192,910	18,805	1.060	0.0975
2002	181,631							

[a] Harvest rate = $R_H = \frac{H_{T,t}}{F_t}$

Table 6. Population budget for Atlantic Brant wintering in North America 1969-70 through 2000-2001. [Derived from Kirby et al. (1985)]

				Harvest				Population					
								Preseason (fall flight)			Postseason (Mid-winter)		
Year (t)	Season	Mid-winter inventory (N_t)[a]	Proportion young (p_t)[a]	Total ($H_{T,t}$)[a]	Age ratio (y/o)($A_{H,t}$)[a]	Young ($H_{Y,t}$)	Other[b] ($H_{A,t}$)	Total ($F_{T,t}$)	Young ($F_{Y,t}$)	Other[b] ($F_{A,t}$)	Young ($N_{Y,(t+1)}$)	Other[b] ($N_{A,(t+1)}$)	Apparent survival [$S_{t\ 6(t+1)}$]
1969	69-70	130,831	0.304	18,387	1.18	9,953	8,434	124,898	37,969	86,929	28,016	78,495	0.6000
1970	70-71	106,511	0.390	25,636	1.02	12,945	12,691	176,601	68,874	107,727	55,929	95,036	0.8923
1971	71-72	150,965	0.057	66,753	0.15	8,707	58,046	139,995	7,980	132,015	-727	73,969	0.4900
1972[c]	72-73	73,242	0.001	0	N/A	0	0	40,835	33	40,802	33	40,802	0.5571
1973[c]	73-74	40,835	0.594	195	1.00	98	98	87,848	52,182	35,666	52,084	35,569	0.8710
1974[c]	74-75	87,653	0.121	235	0.00	0	235	88,643	10,726	77,917	10,726	77,682	0.8862
1975	75-76	88,408	0.442	30,396	1.05	15,569	14,827	157,399	69,570	87,829	54,002	73,001	0.8257
1976[c]	76-77	127,003	0.101	0	N/A	0	0	73,605	7,434	66,171	7,434	66,171	0.5210
1977[c]	77-78	73,605	0.295	572	2.87	424	148	43,312	12,777	30,535	12,353	30,387	0.4128
1978[c]	78-79	42,740	0.053	553	0.38	152	401	44,107	2,338	41,769	2,185	41,369	0.9679
1979[c]	79-80	43,554	0.399	454	1.03	230	224	69,696	27,809	41,887	27,578	41,664	0.9566
1980[c]	80-81	69,242	0.337	100	0.00	0	100	97,128	32,732	64,396	32,732	64,296	0.9286
1981	81-82	97,028	0.179	33,719	0.26	6,958	26,761	138,251	24,747	113,504	17,789	86,743	0.8940
1982	82-83	104,532	0.235	23,584	0.53	8,170	15,414	147,049	34,557	112,492	26,387	97,078	0.9287
1983	83-84	123,465	0.323	34,404	0.56	12,350	22,054	161,721	52,236	109,485	39,886	87,431	0.7081
1984	84-85	127,317	0.213	48,299	0.49	15,884	32,415	194,624	41,455	153,169	25,571	120,754	0.9484
1985	85-86	146,325	0.158	31,434	0.23	5,878	25,556	141,802	22,405	119,397	16,527	93,841	0.6413
1986	86-87	110,368	0.037	9,383	0.07	614	8,769	118,826	4,397	114,429	3,783	105,660	0.9573
1987	87-88	109,443	0.265	8,242	0.56	2,959	5,283	139,425	36,948	102,477	33,989	97,194	0.8881
1988	88-89	131,183	0.267	22,434	0.77	9,759	12,675	160,373	42,820	117,553	33,060	104,879	0.7995
1989	89-90	137,939	0.210	26,148	0.45	8,115	18,033	161,592	33,934	127,658	25,819	109,625	0.7947
1990	90-91	135,444	0.109	14,556	0.24	2,817	11,739	162,300	17,691	144,609	14,873	132,871	0.9810
1991	91-92	147,744	0.245	12,409	0.57	4,505	7,904	197,189	48,311	148,878	43,806	140,974	0.9542
1992	92-93	184,780	0.022	14,124	0.08	1,046	13,078	114,751	2,525	112,226	1,478	99,149	0.5366
1993	93-94	100,627	0.212	10,489	0.73	4,426	6,063	167,648	35,541	132,107	31,115	126,044	1.2526
1994	94-95	157,159	0.101	13,774	0.21	2,391	11,383	161,946	16,357	145,589	13,966	134,206	0.8540
1995	95-96	148,172	0.216	15,586	0.70	6,418	9,168	121,489	26,242	95,247	19,824	86,079	0.5809
1996	96-97	105,903	0.154	5,282	0.14	649	4,633	126,747	19,519	107,228	18,870	102,595	0.9688
1997	97-98	121,465	0.174	18,239	0.43	5,484	12,755	156,213	27,181	129,032	21,697	116,277	0.9573
1998	98-99	137,974	0.241	9,348	0.56	3,356	5,992	180,976	43,615	137,361	40,260	131,368	0.9521
1999	99-2000	171,628	0.015	9,811	0.10	892	8,919	160,988	2,415	158,573	1,523	149,654	0.8720
2000	2000-01	151,177	0.251	18,805	1.17	10,136	8,669	164,066	41,181	122,885	31,045	114,216	0.7268
2001	2001-02	145,261	0.247	31,231	0.53	10,766	20,465	212,862	52,577	160,285	41,811	139,820	0.9625
2002	2002-03	181,631											

[a] Input variables.
[b] Adults and subadults.
[c] No hunting season this year.

Table 7. Submerged aquatic vegetation survey results for the six study areas for the 1980-88 period.

	Plot						
Year	NJ #1	NJ #2	DE	MD	VA #1	VA #2	Total
1980	206.1	89.4	34.4	155.9	29.8	50.5	566.1
1981	57.1	22.9	45.9	149.0	22.9	22.9	320.7
1982	52.1	29.0	34.8	232.0	29.0	23.2	400.1
1983	119.7	62.7	43.9	112.9	42.8	37.1	419.1
1984	223.9	97.6	83.2	143.5	50.2	80.4	678.8
1985	53.1	64.3	37.3	124.3	27.6	55.9	362.5
1986	107.7	74.2	5.9	82.0	33.2	47.4	350.4
1987	205.5	73.2	23.0	169.3	76.0	71.7	618.7
1988	6.0	6.7	87.4	205.8	53.4	55.1	414.4
Mean	114.6	57.8	44.0	152.7	40.5	49.4	459.0
SE	26.73	10.42	8.77	15.31	5.65	6.54	42.91
Plot size (ac)	1,302.1	401.2	967.1	963.3	607.8	557.3	4,798.8

SECTION 5.
SURVEYS

Operational

Mid-Winter Waterfowl Survey. — The Mid-Winter Waterfowl Survey (MWS) provides the only assessment of Atlantic brant population size available at this time. The MWS is a once-per-year survey conducted by zones and segments that focus on the waterfowl wintering areas with the highest concentrations of birds. Therefore, the survey provides a relative index to the abundance of birds from year to year. It is mostly conducted from aircraft with some ground and boat counts. The data collection and analysis protocols are currently (2001) under review by the U.S. Fish and Wildlife Service, Atlantic Flyway Council, and Atlantic Flyway states.

Fall goose productivity survey. — The best records of breeding success come from the fall productivity surveys where age ratios and family sizes are recorded in wintering flocks along the US Atlantic seaboard. Data for the period 1969-1999 are listed in Table 1. Over those years, the fall flights of Atlantic brant contained, on average, 20.9% young (SE = 2.5%, CV = 65.96) with extremes of <1% (1972) and 59.4% (1974). Median percent young was 21.2. In 6 of those years (19.4% or about 1 in 5) there was overall breeding failure (<10% young).

Inactive

Spring habitat conditions survey using satellite images. — This project was an attempt to use advanced very high resolution radiometer data to develop quantitative regression models to estimate immature-to-adult ratios of goose populations in the fall flight. The models developed were intended to augment qualitative production forecasts derived from communications with researchers and residents on the breeding grounds and from interpretation of weekly Northern Hemisphere Snow and Ice Boundary summaries prepared by the National Oceanic and Atmospheric Administration (Strong and Trost 1994). However, model performance was poor

because predictions were often made from outside of the limits of the data used in developing the model and the project is no longer active (G. Smith, USFWS, Laurel, MD, personal communication).

Spring aerial high arctic survey. — This was a low-altitude airborne survey of the principal known goose breeding areas in the Canadian arctic conducted in the late 1980's and early 1990's. The surveys were conducted in mid- to late-June with the goals of making qualitative assessments of breeding habitats and nest phenology and of developing a quantitative database for monitoring conditions of nest habitat and predicting fall age ratios of arctic-nesting geese (Nieman et al. 1993). Specific objectives included assessment of the extent of snow cover on goose nesting areas; development of regression estimators to forecast age ratios in the fall flight; monitoring of changes in breeding densities in key areas; and to detect and measure the affect of catastrophic events on breeding populations (Nieman et al. 1993:3-4).

Submerged Aquatic Vegetation (Sea Lettuce) Survey. — Sea lettuce and eelgrass are the principle food sources for wintering brant along the Atlantic Coast. Both of these plants have suffered production failures in the past. A production failure during the winter of 1977-78 coupled with severe winter weather resulted in the starvation and death of approximately two thirds of the Atlantic Coast wintering brant population. An aerial survey was established during the winter of 1980-81 to measure the relative abundance of sea lettuce and eelgrass in principal brant wintering grounds. The purpose of this survey was to provide an early warning of potential food supply problems, so that management agencies could avoid another massive die-off.

The submerged aquatic vegetation survey was conducted in October from 1980 to 1988. Study areas were selected in New Jersey (2), Delaware (1), Maryland (1) and Virginia (2) in

areas traditionally used by Atlantic brant. Aerial reconnaissance was made of these areas and sites with well-defined boundaries were selected to facilitate photography. The selected sites were plotted on 1:24,000 scale, 7.5 minute quadrangle maps. Plot sizes varied from 401.2 acres to 1,032.1 acres and the total area was 4,798.8 acres (Table B-7). Vertical photographs were taken at 4,500 feet from a Cessna 182 using an Olympus OM2 with a 35 mm, f 2.8 lens and Kodak Kodachrome 64 ASA film. Ground surveys were conducted on each plot by State and Federal cooperators to determine the vegetation type. Vegetation beds appearing in the photographs were plotted on the quadrangle maps and the acreage determined by a planimeter. The Division of Migratory Bird Management maintains the historic files for this database, including study area locations and aerial photography.

The base year for this survey was 1980, which was considered to be an excellent year for submerged aquatic vegetation. This survey also identified 1984 and 1987 as above average years (above the long-term mean of 458.98 acres) (Table 7). No significant failures in submerged aquatic vegetation production were encountered during the 1980-88 period. This survey was discontinued in 1989 for budget reasons.

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